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Shyness and Vocabulary

The Roles of Executive Functioning and Home Environmental Stimulation

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Although shyness has often been found to be negatively related to vocabulary, few studies have examined the processes that produce or modify this relation. The present study examined executive functioning skills and home environmental stimulation as potential mediating and moderating mechanisms. A sample of 3½-year-old children (N = 254) was administered executive functioning tasks and a vocabulary test during a laboratory visit. Mothers completed questionnaires assessing child shyness and home environmental stimulation. Our primary hypothesis was that executive functioning mediates the association between shyness and vocabulary, and home environmental stimulation moderates the relation between executive functioning and vocabulary. Alternative hypotheses were also tested. Results indicated that children with better executive functioning skills developed stronger vocabularies when reared in more, versus less, stimulating environments. Implications of these results are discussed in terms of the role of shyness, executive functioning, and home environmental stimulation in early vocabulary development.

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Although there are currently different conceptualizations about the origins and definitions of shyness, one common thread among various definitions is that *shyness* involves wariness about, and fear of, people and social stimuli that are unfamiliar (Eisenberg, Shepard, Fabes, Murphy, & Guthrie, 1998; Evans, 2001; Gartstein & Rothbart, 2003). In young children, shyness is usually measured through behavioral observation (e.g., crying at presentation of a novel stimulus), physiological reactivity (e.g., heart rate increase accompanying presentation of an unfamiliar stimulus), and parent reports of child behavior (e.g., child is uncomfortable asking other children to play; child does not like to try new activities; child is wary of strangers). By using various indicators, individual differences in shyness have been observed at every stage of the life span (Asendorpf, 1990; Burgess, Marshall, Rubin, & Fox, 2003; Sanson, Pedlow, Cann, Prior, & Oberklaid, 1996; Scarpa, Raine, Venables, & Mednick, 1995). Shyness is thought to be maladaptive (Schmidt & Tasker, 2000; Scott, 2006) and, indeed, childhood shyness has been found to be related to health and behavior problems (Evans, 2001; Kerr, 2000). Evidence has also indicated that shyness is related to social maladjustment—peer rejection, anxiety, depression, and loneliness (Rubin, LeMare, & Lollis, 1990; Sroufe, 1977)—and that these relationships extend into adolescence (Kerr, 2000).

The significance of early temperamental characteristics, such as shyness, to later development makes it important to investigate such characteristics and the conditions under which they may or may not be related to outcomes. Although research has been conducted on the psychosocial correlates of early childhood shyness, research on the cognitive correlates of early childhood shyness is in its infancy. The goal of the present research was to further our understanding of the mechanisms underlying the link between shyness and vocabulary in a sample of 3½-year-old children through an examination of the role of executive functioning skills and home environmental stimulation in this relation. Our hypothesized model of the relations among these variables appears as Figure 1. Because there has been relatively little prior research to support the specific relations we propose, alternative models testing shyness as a moderator and as a mediator of the relation between executive functioning and vocabulary were also examined.

The importance of vocabulary to life success makes it of practical importance for investigation (Gathercole, Willis, Emslie, & Baddeley, 1992; Hoff, 2007). It is particularly important to examine vocabulary development early in life because it has important implications for development and achievement throughout the life span (Hart & Risley, 1995; Kastner, May, & Hildman, 2001; Vineyard & Massey, 1957). For example, children's

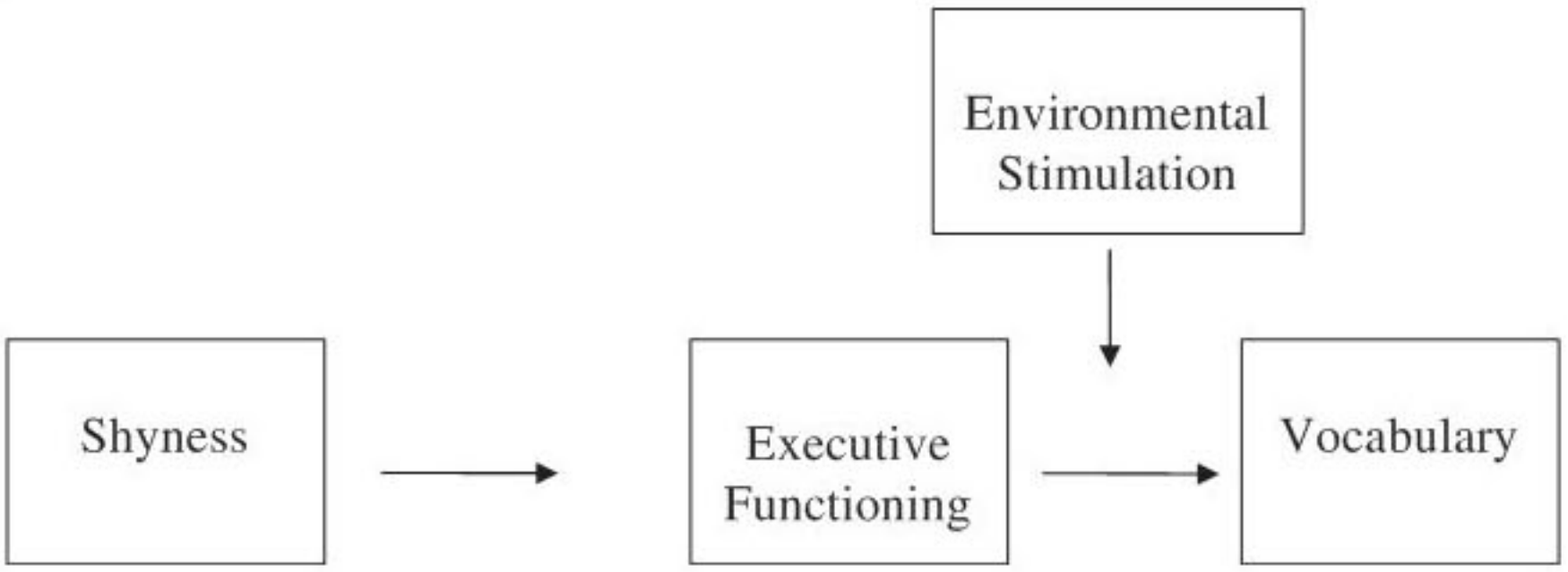

Figure 1. Environmental stimulation as moderator of the mediation of executive functioning in the relationship between shyness and vocabulary.

prereading vocabulary is an important predictor of their later reading competence, which has links not only with academic success but with life success in general (Chall, 1983; Hart & Risley, 1995). Thus, examining the associations between shyness and vocabulary in early childhood may be useful for treatment and intervention efforts.

Shyness and Vocabulary

There is some evidence that shyness is negatively related to vocabulary (e.g., Paul & Kellogg, 1997; Slomkowski, Nelson, Dunn, & Plomin, 1992), although others have not found this relation (e.g., Coplan & Armer, 2005; Dixon & Smith, 2000; Ludwig & Lazarus, 1983). Research by Gewirtz (1948) indicated that shyness (measured with teacher ratings of social apprehension) correlated negatively with expressive language abilities in a sample of 5- and 6-year-old children. More recent evidence supports this early finding of a negative relation between shyness and productive vocabulary (e.g., Paul & Kellogg, 1997; Prior et al., 2008; Spere, Schmidt, Theall-Honey, & Martin-Chang, 2004). Shyness has also been found to be negatively related to receptive vocabulary (Slomkowski et al., 1992; Spere et al., 2004).

A negative association between shyness and vocabulary is in accord with the interactionist perspective of language development, which emphasizes that language abilities emerge from a child's interactions with the environment. The development of cognitive abilities requires that one learn about the unfamiliar (Horn & Blankson, 2005; Piaget, 1960). To the extent that social anxiety or withdrawal inhibits one from learning

about the unfamiliar, shyness would be expected to be negatively related to vocabulary.

Although numerous studies have examined direct relations between shyness and vocabulary, little research has been conducted on the processes by which shyness and vocabulary are related, or the conditions under which shyness does or does not hinder vocabulary acquisition. Thus, the mechanism by which shyness comes to be related to vocabulary is not yet fully understood. In this study, we used a sample of 3½-year-old children to investigate the potential impact of executive functioning skills, and we explored the role of home environmental stimulation in these associations.

Shyness and Executive Functioning

Executive functioning refers to a variety of related cognitive skills that involve the ability to maintain task-relevant information in short-term memory, as well as the ability to manipulate this information through the engagement of focused attention (National Institute of Child Health and Human Development Early Child Care Research Network [NICHD ECCRN], 2005; Wolfe & Bell, 2007). Among these skills are working memory and cognitive inhibitory control, both of which are associated with frontal lobe function. Children who are able to engage in goal-directed behavior by reducing their attention to distracting stimuli, either internal or external, demonstrate such skills. When in a learning situation with other children or adults, increasing levels of shyness may be associated with a decreased ability to focus attention on the task at hand. Thus, the processing of cognitive information by shy children might be limited by social anxiety such that executive functioning skills, such as working memory and cognitive inhibitory control, are hampered (Arnold & Cheek, 1986; Ludwig & Lazarus, 1983). For example, in a sample of fourth- and fifth-grade students, shy children performed less well on the Stroop Color-Word Test than did their less shy counterparts (Ludwig & Lazarus, 1983). Additionally, studies have shown a negative relationship between shyness and working memory (Humphreys & Revelle, 1984; Lieberman, 2000; Tanwar & Malhotra, 1992).

There is evidence that individual differences in shyness emerge in infancy and are relatively stable across the life span (Burgess et al., 2003; Sanson et al., 1996; Scarpa et al., 1995). These individual differences emerge before the maturation of frontal lobes that are typically implicated in the development of executive functioning (Diamond & Doar, 1989). Although the early precursors for executive functioning are observed in the first years of life (Diamond, 1991), these abilities continue to develop

throughout childhood (Garon, Bryson, & Smith, 2008; Rueda, Posner, & Rothbart, 2005). Thus, it may be the case that negative affect, such as that associated with shyness, may be related to the development of executive functioning skills (Blair & Peters, 2003).

Executive Functioning and Vocabulary

Individual differences in executive functioning have been found to be positively related to individual differences in vocabulary (Blair & Razza, 2007; Gathercole et al., 1992; McClelland et al., 2007; Wolfe & Bell, 2007). In particular, the findings by Gathercole and colleagues (e.g., Adams & Gathercole, 1995; Gathercole & Baddeley, 1989) suggest that executive functioning predicts vocabulary early in development. It has been suggested that executive control may enable one to distribute attention properly either to words in a word-learning event or away from other distracting stimuli in word-learning situations (Dixon, Salley, & Clements, 2006). Thus, our principal hypothesis (shown in Figure 1) was that shyness restricts executive functioning, thereby reducing distribution of attention toward word-learning events and in turn hindering the development of vocabulary.

Two alternative hypotheses were also tested. First, it could be that the relation between executive functioning and vocabulary may differ for different levels of shyness. Individuals who are not shy may engage with their social environments more actively and develop language skills regardless of their executive functioning skills. For shy individuals, however, executive functioning skills may be needed to shift attentional focus away from the self and toward word-learning events. If so, the relation between executive functioning and vocabulary may be stronger for shyer individuals. Thus, we tested the alternative hypothesis that shyness moderates the relation between executive functioning and vocabulary.

Additionally, although we expected to find that executive functioning mediates the relation between shyness and vocabulary, we also tested shyness as a mediator of the executive functioning–vocabulary relationship. It could be that decreasing levels of executive functioning may lead to increased levels of shyness, which in turn may affect vocabulary development. Moreover, given that the data were collected concurrently, this hypothesis is an equally plausible alternative to our primary hypothesis. Thus, we tested this alternative hypothesis to account for the issue of directionality of effects. Testing of both alternative hypotheses was considered important because the links between and among shyness, executive functioning, and vocabulary have not been extensively studied in past work.

The Role of Environmental Stimulation

Exploration of, and engagement with, the environment fosters the development of vocabulary (Hart, 2004; Horn & Blankson, 2005; Main, 1983; Tomasello, 1992). Family environments provide opportunities for the development of vocabulary. Individuals who are reared in home environments that encourage exploration have many opportunities for the development of vocabulary. Indeed, research has repeatedly supported the proposition that *opportunities for productive activity*—the extent to which toys and learning materials are available in the home environment, along with the extent to which parents directly teach their child concepts and take their child to places and events that provide enrichment—are positively related to vocabulary (Bradley & Corwyn, 2005; Bradley, Corwyn, Burchinal, McAdoo, & Garcia Coll, 2001; Griffin & Morrison, 1997). Research also indicates that engagement in productive activities is related to attention focusing and memory, both of which are elements of executive functioning (NICHD ECCRN, 2005).

In light of this evidence, we explored the extent to which environmental stimulation moderates the path from executive functioning to vocabulary. It could be the case that for children who are reared in stimulating environments, the stronger their executive functioning skills are, the more these children are able to benefit from their environments. Thus, the relation between executive functioning and vocabulary may be stronger in more stimulating home environments such that children with higher executive functioning skills who are reared in stimulating environments have an added benefit and therefore have larger vocabularies than their counterparts with lower executive functioning skills who may be overwhelmed by the toys and materials in stimulating homes and/or may not engage in the types of activities and play that would enhance vocabulary to the extent that those with higher executive functioning skills do. In less stimulating environments, the association between executive functioning skills may not be as strong because the opportunities for the development of vocabulary are themselves limited; thus, having better executive functioning skills may not be beneficial in such homes. However, an alternate hypothesis is also plausible for the reason that when the home environment is more impoverished, learning words in such environments might require stronger executive functioning skills. Thus, it could be the case that the relation between executive functioning and vocabulary would be stronger in less stimulating home environments rather than in more stimulating environments. In less stimulating home environments, children with stronger executive functioning skills may be better able to make use of the materials that are in the home, whereas in more

stimulating home environments, executive functioning skills need not be particularly heavily involved.

Moderation of the relation between executive functioning and vocabulary by home environmental stimulation would suggest that the mediation effect of shyness on vocabulary through executive functioning would also be moderated by home environmental stimulation. Hence, stimulation in the home environment is expected to alter the relation between shyness and the development of vocabulary through executive functioning skills such that the negative relation between shyness and vocabulary through executive functioning skills will differ across different levels of home environmental stimulation.

Overview of Study Hypotheses

Previous research and theory suggests that (a) shyness is negatively related to vocabulary acquisition, (b) shyness is negatively related to executive functioning, (c) executive function is related to vocabulary acquisition in early childhood, and (d) home environmental stimulation is positively related to executive function and vocabulary acquisition. Based on this theoretical and empirical background, we proposed the following hypotheses: (1) There will be a negative relation between shyness and executive functioning. (2) There will be a positive relation between executive functioning and vocabulary. (3) There will be a significant and negative indirect relation between shyness and vocabulary through executive functioning, and that relation will be moderated by home environmental stimulation. No hypothesis was specified about the direct relation between shyness and vocabulary because our hypotheses suggest shyness will have different effects in different contexts. Furthermore, evidence of a significant effect of the predictor on the criterion variable is not required for evidence of mediation or an indirect effect (MacKinnon, Krull, & Lockwood, 2000). The alternative hypotheses of shyness as a moderator or mediator between executive functioning and vocabulary were also examined.

Methods

Participants

The sample was comprised of children and their mothers who participated in a study examining emotional and cognitive contributions to early school success. The present analyses were conducted using the sample of children who at age 3½ years had complete data on the study variables ($N = 254$).

Children with incomplete data ($N = 9$) were from families with lower income ($t[257] = 2.25$, $p < .05$) than the included children. No other comparisons on demographic variables (child gender, child age, child ethnicity, maternal age, and maternal education) were significant. Mothers[1] in the study sample were 33 years of age on average ($SD = 5.87$). Approximately 51% had a 4-year college degree or had completed higher levels of education, 75% of the respondents were married and living with their partner, and 79% were currently working outside the home. Average income-to-needs ratio, derived by dividing the total family income by the poverty threshold for that family size, was 2.92 ($SD = 1.72$). Approximately 23% of the sample had an income-to-needs ratio that was ≤ 1, 67% had a ratio between 2 and 5, and 10% had a ratio that was >5. Mean age of the children was 41.79 months ($SD = 2.40$). Of the children, 52% were girls, 59% were European American, 35% were African American, and 6% were of other ethnicities.

Participating families were recruited from preschools and child-care centers in a small southeastern city through letters sent home with the children. Families interested in participating returned contact information to the researchers, who then called the families to schedule a laboratory visit that lasted approximately 2 hours. Mothers provided written consent before the start of the session, during which time children played a game with the experimenter. During the lab session, children were videotaped while completing tasks assessing executive functioning and vocabulary, with task order held constant across children. The executive functioning and vocabulary tasks were administered a half hour to 1 hour into the protocol; the children were accustomed to the testing session by this time. Mothers completed questionnaires during the session. Families received $40, and children selected a toy as thanks for their participation.

Measures

Shyness was measured with the Children's Behavior Questionnaire Short Form (CBQ-Short; Putnam & Rothbart, 2006), which assesses temperament in 3- to 7-year-olds. Mothers described their child's typical reactions to various situations by using a 7-point Likert scale ranging from 1 (extremely untrue of your child) to 7 (extremely true of your child). Of interest in the present analyses was the 7-item shyness subscale (e.g., "Acts shy

1. Of the 254 children, one child was accompanied to the lab by his father, who was the primary caregiver; three by their grandmothers, with whom the children lived; and all others by their mothers. Caregivers are referred to as mothers.

around new people"). Items were averaged (Cronbach's alpha was .76) to yield a measure of shyness.

Executive functioning was measured with two tasks, the Day/Night Stroop task (hereafter, Stroop) (Gerstadt, Hong, & Diamond, 1994), and the Kaufman Assessment Battery for Children (K-ABC; Kaufman & Kaufman, 1983) *number recall test.* The Stroop was developed from the classic task (Stroop, 1935) that is widely used to index cognitive inhibitory control. Children were presented with a deck of cards, half of which were black with a yellow moon and several stars, and half were white with a bright sun. Children were instructed to say "day" in response to the black cards and "night" to the white cards. Following two practice trials, each type of card was presented eight times in a fixed order (16 in total). Children were administered the test trials only if they answered at least one question correctly in two practice trials. Children who failed both practice trials received a score of zero ($n = 74$). The possible range of scores was from 0 to 16, with higher scores indicating stronger cognitive control or inhibition. The number recall subtest of the K-ABC was administered to children to assess working memory capacity. The examiner recited a series of numbers, and children were asked to repeat them in the same sequence. Number sequences increased in size until children missed three sequences in a row. Each sequence was scored as correct (1) or incorrect (0). The raw score was computed as the difference between the ceiling item and the total number of errors. The Stroop and number recall test scores correlated significantly ($r = .42$, $p < .01$) in the sample and were standardized and summed to form an executive functioning composite.[2]

Home environmental stimulation was measured by using two questionnaires, Watching Television, Reading, and Computers at Home (TVRC) and the Toys and Activities Questionnaire (TAQ), that were completed by the caregiver. The TVRC is comprised of nine items ($\alpha = .57$) and was adapted for the study from a measure by Griffin and Morrison (1997). Example items include "number of books owned by child" and "someone reads to child at home." The TAQ is comprised of 20 items ($\alpha = .65$) and was adapted for the study from the Home Observation for Measurement of the Environment (Caldwell & Bradley, 1984). Example items include "In your home, does your child have toys that help him/her learn colors?" and "Do you encourage your child to read a few words in his/her books?" The TVRC and TAQ scores correlated significantly ($r = .49$, $p < .01$) and were standardized and summed to form a home environmental stimulation

2. Conclusions were the same when the tasks were examined separately.

composite ($\alpha = .66$). The composite represents the extent to which toys and learning materials are available in the home environment, the child engages with the toys and learning materials, and parents directly teach their child concepts and take their child to places and events that provide enrichment.

Vocabulary was measured with the Peabody Picture Vocabulary Test, third edition (PPVT; Dunn & Dunn, 1997), which is a standardized measure of receptive vocabulary. Items are arranged in 17 sets of 12 items. For each item, the child was asked to point to one of four drawings named by the examiner. Items were administered by complete sets until the child missed eight in a set, upon which time testing stopped. A raw score was computed as the difference between the ceiling item and the number of errors made in all of the sets administered. The possible range of scores was from 0 to 204.

Results

The correlations, means, and standard deviations for the major study variables are displayed in Table 1. As expected, shyness and executive functioning were negatively correlated. Additionally, both executive functioning and home environmental stimulation were positively correlated with vocabulary.

To address the primary research question, we used a bootstrap procedure described by Preacher, Rucker, and Hayes (2007). The bootstrap method is considered superior to other methods for testing mediation, such as the Baron and Kenny (1986) causal steps approach (MacKinnon, Lockwood, Hoffman, West, & Sheets, 2002). The Preacher et al. macros for testing moderated mediation produces a simple ordinary least squares (OLS) regression test for a mediator variable model (shyness on executive functioning), along with a test for a dependent variable model (shyness and executive functioning on vocabulary) that includes any relevant interaction terms. The interaction terms in the model test for moderation of the meditation hypothesis.

To probe significant moderated mediation effects, conditional indirect effects are tested for significance by using the Preacher et al. (2007) macros; that is, whether the indirect effect (of shyness on vocabulary in this case) is significant at specific levels of the moderator (home environmental stimulation) is tested, similar to the Aiken and West (1991) methods for probing significant interactions. More specifically, k bootstrap samples (usually 1,000 or greater) of N units are drawn from the original sample of N units, with replacement, and the indirect effect is calculated for each sample as the product of the unstandardized weight for the path from the

Table 1. Zero-Order Correlations, Means, and Standard Deviations for Major Study Variables

Variable	1	2	3	4
1. Shyness	—			
2. Executive Functioning	–0.16*	—		
3. Home Environmental Stimulation	0.02	0.11	—	
4. Vocabulary	–0.10	0.41**	0.30**	—
M	3.82	0.01	0.01	42.39
SD	1.18	1.68	1.68	16.39

*$p \leq .05$, two-tailed. **$p \leq .01$, two-tailed.

predictor to the mediator and the unstandardized weight for the path from the mediator to the outcome variable at various levels of the moderator. An average indirect effect is calculated as the mean across the k samples along with a 95% bias corrected and accelerated confidence interval for the indirect effect that does not assume normality of the sampling distribution of the test statistic or the variables in the analysis. The null hypothesis of no indirect effect is rejected if the confidence interval does not contain zero (MacKinnon, Lockwood, & Williams, 2004).

Preacher et al. (2007) discuss at least five ways in which an indirect effect can be dependent upon a moderator. Because our hypotheses specified an interaction between executive functioning and environmental stimulation, we specified Preacher et al.'s model 3, testing the significance of the interaction between executive functioning and home environmental stimulation in predicting vocabulary. (The interaction between home environmental stimulation and shyness on executive functioning was tested and was not significant.) Child gender, ethnicity (dichotomized to distinguish European American children [=0] from non-European American children [=1]), age in months, and family income-to-needs ratio were entered as covariates. Examination of interaction effects with these variables was beyond the scope of this report.

Results of the OLS regressions that provide a test of the mediation hypothesis (executive functioning as a mediator of the shyness-vocabulary link) are presented in Table 2. For the mediator variable model, the path from shyness to executive functioning was negative and significant, as expected. For the dependent variable model, the path from executive functioning to vocabulary was significant.

The hypothesis that home environmental stimulation will moderate the association between executive functioning and vocabulary was tested

Table 2. Test of Moderated Mediation

Predictors	*b*	*SE*	*t*
Mediator Variable Model (Predicting Executive Functioning)			
Shyness	–0.19	0.09	–2.20*
Gender	–0.51	0.20	–2.46*
Ethnicity	–0.11	0.21	–0.51
Age	0.12	0.04	2.61**
Income-to-Needs Ratio	0.21	0.06	3.37**
Dependent Variable Model (Predicting Vocabulary)			
Shyness	–0.29	0.75	–0.38
Executive Functioning	3.05	0.54	5.60**
Environmental Stimulation	2.00	0.56	3.55**
Executive Functioning × Environmental Stimulation	0.73	0.32	2.32*
Gender	–3.50	1.77	–1.98*
Ethnicity	–5.66	1.84	–3.07**
Age	1.20	0.38	3.16**
Income-to-Needs Ratio	1.13	0.56	2.00*

*$p \leq .05$, two-tailed. **$p \leq .01$, two-tailed.

by examining the significance of the interaction between executive functioning and environmental stimulation in the prediction of vocabulary. As can be seen in Table 2 under the dependent variable model, the executive functioning by environmental stimulation interaction was significant. This interaction is depicted in Figure 2, at ±1 *SD* from the mean of home environmental stimulation. The positive relation between executive functioning and vocabulary was stronger in home environments that are more stimulating.

The significance of the moderation effect suggests that the mediation effect is also moderated. The moderation of home environmental stimulation in the indirect effect of shyness to vocabulary through executive functioning is depicted in Figure 3 at ±1 *SD* from the mean. To further probe the moderated mediation effect, bootstrap estimates of the indirect effects, along with bias corrected and accelerated bootstrap confidence intervals for the indirect effect, were calculated at the mean environmental stimulation, as well as at ±1 *SD* from the mean, based on 5,000 bootstrapped samples. These results are presented in Table 3. The indirect effect was negative and significant at the mean and at 1 *SD* above the mean for home

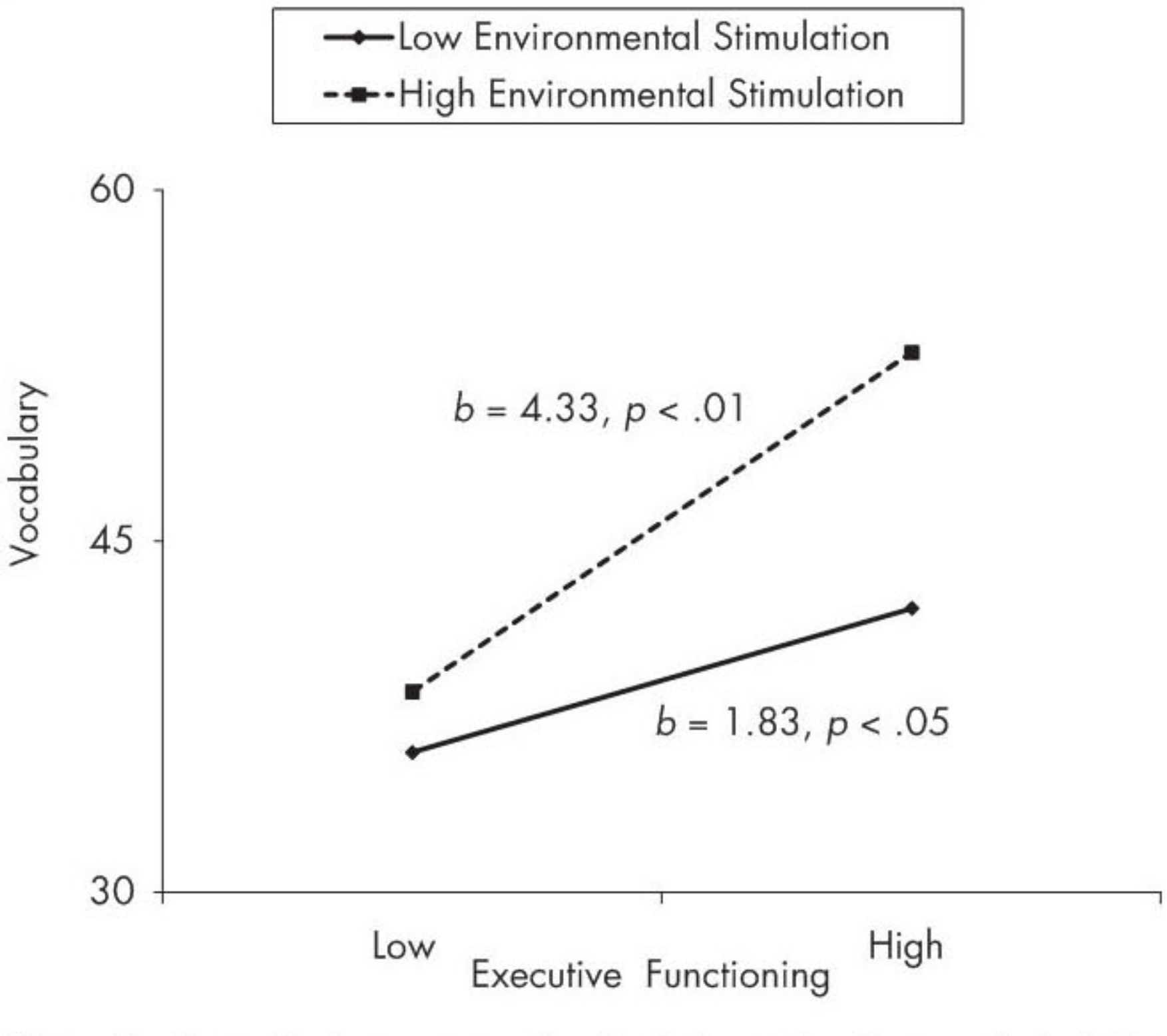

Figure 2. Interaction between executive functioning and environmental stimulation in the prediction of vocabulary.

environmental stimulation. The indirect effect was not significant at the .05 level at 1 *SD* below the mean, although the confidence interval does not contain zero, therefore suggesting significance. Thus, the indirect relation between shyness and vocabulary via executive function was most robust when environmental stimulation was average or high.

Two alternative hypotheses were tested. The first examined whether shyness moderates the association between executive functioning and vocabulary. This hypothesis was tested by using hierarchical multiple regression. The first step of the regression analysis included the predictor variables and the covariates. The second step included the interaction between shyness and executive functioning. Results are presented in Table 4. The interaction between shyness and executive functioning was not significant in the second step of the regression, nor was the F change significant ($\Delta F = 2.42$, $p = .12$). The second alternative hypothesis examined shyness

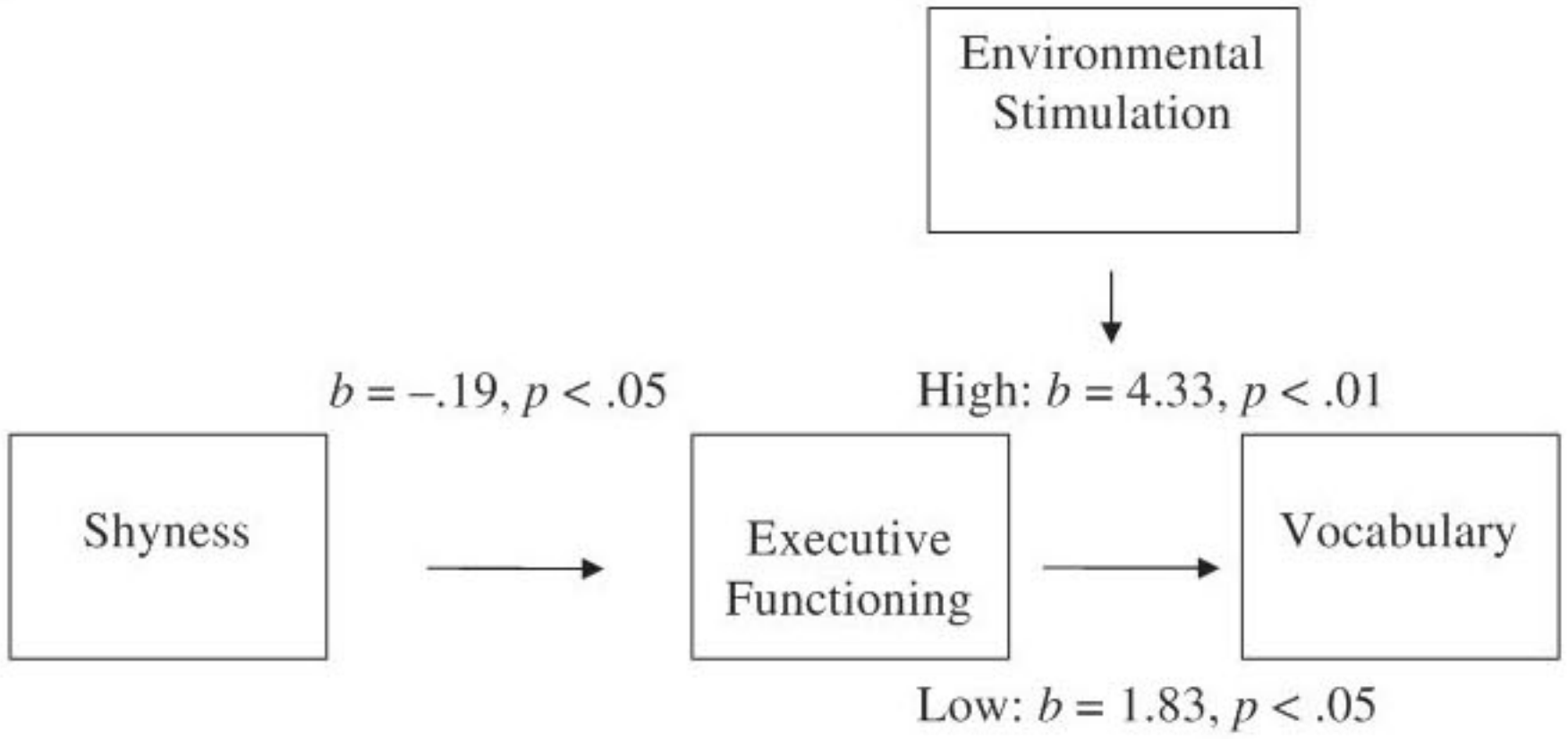

Figure 3. Moderation of home environmental stimulation in the indirect relation between shyness and vocabulary through executive functioning.

as a mediator of the executive functioning–vocabulary relation. This hypothesis was tested by using a bootstrap procedure similar to that already described for the test of moderated mediation (Preacher & Hayes, 2004). The estimated indirect effect was .04, 95% CI [–.09, .28]. Because the confidence interval for the indirect effect contained zero, we failed to reject the null hypothesis of no indirect effect.

Discussion

The primary questions of the present study were whether there was a significant indirect effect of shyness on vocabulary through executive functioning and whether home environmental stimulation moderated the mediated link

Table 3. Indirect Effect of Shyness on Vocabulary Via Executive Functioning at Various Levels of Environmental Stimulation

Level	Coefficient	95% CI	*SE*	*z*
1 *SD* below mean	–0.36	[–1.00, –0.01]	0.24	–1.47
Mean	–0.59	[–1.26, –0.06]	0.30	–1.97*
1 *SD* above mean	–0.82	[–1.72, –0.09]	0.41	–2.01*

Note. CI = confidence interval.

*$p \leq .05$, two-tailed.

Table 4. Moderation Between Shyness and Executive Functioning in the Prediction of Vocabulary

Predictors	*b*	*SE*	*t*	ΔR^2	ΔF
Step 1: df = 6, 247				0.28	15.63**
Shyness	–0.37	0.77	–0.48		
Executive Functioning	3.20	0.56	5.73**		
Gender	–4.06	1.81	–2.24*		
Ethnicity	–6.79	1.86	–3.64**		
Age	1.13	0.39	2.88**		
Income-to-Needs Ratio	0.21	0.06	3.37**		
Step 2: df = 7, 246				0.01	2.42
Shy × Executive Functioning	0.70	0.45	1.56		

*$p \leq .05$, two-tailed. **$p \leq .01$, two-tailed.

between shyness and vocabulary. Consistent with our expectations, executive functioning mediated the shyness-vocabulary link, and the mediation was stronger at high levels of environmental stimulation. Examination of alternative hypotheses in which shyness was tested as a moderator or mediator of the relation between executive functioning and vocabulary found no evidence for these relationships.

That shyness was indirectly linked with poorer vocabulary scores is consistent with the results of some previous research (e.g., Gewirtz, 1948; Spere et al., 2004), suggesting that shyness may be negatively associated with vocabulary acquisition. The finding of a positive relation between executive functioning and vocabulary also supports the results of previous research (e.g., Gathercole et al., 1992; McClelland et al., 2007), adding more evidence to the notion that cognitive control is necessary in the acquisition of vocabulary. These findings call attention to the importance of executive functioning skills in development and the need for further research that addresses the link between shyness and executive functioning.

The significance of the indirect link between shyness and vocabulary through executive functioning suggests that shyness may be associated with the distribution of attention toward word-learning events through the relation with executive functioning skills. This in turn may be associated with the acquisition of vocabulary. These effects, however, were more pronounced in stimulating home environments; children with better executive functioning skills develop stronger vocabularies when reared in stimulating environments than when reared in less stimulating environments. The

negative arousal of shy children in social situations may interfere with their ability to exert the cognitive control necessary to learn new words, particularly in stimulating environments.

Results of this research indicated a significant interaction between executive functioning and environmental stimulation in the prediction of vocabulary. This result implies that children with higher executive functioning skills who are reared in more environmentally stimulating homes may be more likely to develop large vocabularies compared to children with higher executive functioning skills who are reared in less stimulating environments; children with stronger executive functioning skills who are reared in stimulating environments might have an added bonus and therefore develop better vocabularies than their counterparts who are reared in less stimulating environments.

Home environmental stimulation is important for all children, regardless of their temperamental characteristics. However, our results indicate that not all children may benefit fully from the environmental stimulation parents provide. First, results indicated that children with weaker executive functioning skills who are raised in more stimulating environments may perform no better than their counterparts who are reared in less stimulating environments. Thus, home environmental stimulation may not by itself promote the development of vocabulary in all children. Additionally, the negative association that we observed between shyness and executive functioning skills suggests that shy children may benefit less than other children from their stimulating environments with regard to vocabulary development to the extent that shyness may interfere with the effectiveness of executive functioning skills.

The results of the present study have important applications for intervention and treatment efforts for children and for making educators and caregivers aware of the challenges that children may face in the development of vocabulary. Most early intervention programs target *at risk* children—children who are often reared in families of low socioeconomic status. The effect of home environmental stimulation on child outcomes in the present study was significant over and above income differences, highlighting the importance of home environmental stimulation in child outcomes. However, the findings of this research suggest that it is the combination of a stimulating environment along with child characteristics that produce the strongest outcomes in vocabulary acquisition.

Although results of this research highlight the importance of the development and/or maintenance of intervention methods and programs that are aimed at improving the environmental stimulation received by children in their homes, such interventions may not be beneficial for all children.

Moreover, the findings of this research underscore the importance of executive functioning skills in development. Based on findings that executive functioning is positively related to vocabulary, it is possible that interventions and treatments for improving the outcomes of children, perhaps especially shy children, could be targeted at improving executive functioning skills, particularly in the early years. There is research indicating that executive functioning skills can be enhanced through training and schooling (Diamond, Barnett, Thomas, & Munro, 2007; McCrea, Mueller, & Parrila, 1999), suggesting that incorporating such training procedures into treatment protocols for children might prove fruitful in terms of vocabulary development.

Several limitations of the present research should be noted. Foremost, the data were collected at only one time point. Although there is evidence to support the hypothesized direction of effects, we acknowledge that the relations among the variables examined in this research may operate in a manner other than that specified by our model. For example, it has been suggested that some forms of shyness may appear early in infancy, whereas other forms may appear around the age of 4 or 5, after the emergence of a "sense of self" (Cheek, 1998; Crozier, 2002). Therefore, it could be that executive functioning skills, vocabulary, and shyness have reciprocal relationships. However, alternative hypotheses, such as the possibility that shyness mediates the link between executive functioning and vocabulary, and the hypothesis that shyness moderates the link between executive functioning and vocabulary, were tested and were not supported by these data. Nevertheless, that the present research design was nonexperimental, such that random selection and random assignment were not employed, restricts our ability to determine the temporal order of effects. Therefore, statements about causality should be interpreted cautiously.

An additional limitation was that only receptive vocabulary was examined. Although productive and receptive vocabulary abilities are related, research has more consistently found a negative relation between shyness and productive vocabulary than between shyness and receptive vocabulary (Coplan & Armer, 2005). We speculate that results obtained by using productive vocabulary measures would be similar to those obtained in this study. However, further research is needed to examine the extent to which this is the case.

It is also possible that shy children do not display their knowledge of vocabulary or executive functioning in unfamiliar research settings. To the extent that shyness is provoked by the novelty of the experimental setting, children's responses may be inhibited. We believe this possible limitation was minimized for several reasons in the present study. First, as previously mentioned, our measure of vocabulary was receptive rather than productive,

and shy children are likely to perform better on tests of receptive vocabulary than on tests of productive vocabulary (Crozier & Hostettler, 2003). Furthermore, the vocabulary and executive functioning tests were administered 30–60 minutes into the laboratory session, giving the children time to become comfortable with the situation and build rapport with the experimenter, and the lab protocol included activities that aided in the maintenance of rapport throughout the visit. Nevertheless, research suggests that shyness may impede rapport-building efforts (Rotenberg et al., 2003). Therefore, further research should be conducted under conditions that may be more familiar to shy children to determine whether results replicate. However, in young children of prereading age, the source of vocabulary development is primarily through audition and interaction with others. Therefore, even if child performance were restricted by shyness rather than actual capabilities, this does not run counter to our conjecture that executive functioning skills may decrease with increasing levels of shyness, which in turn may be implicated in the development of vocabulary; such a finding may actually provide increased support for our hypothesis. Similarly, the novelty associated with laboratory settings are in some ways similar to school settings in the sense that school settings can also be very novel and socially intimidating to shy children. Thus, the examination of shyness in the laboratory perhaps represents a more ecologically valid assessment of the kind of problems that will eventually emerge in the school setting than would examination of shyness in more familiar settings.[3]

In addition to the limitations of the research, there are also several strengths, one of them being the diversity of the sample. Research on the relation between and among shyness, vocabulary, and executive functioning have often been conducted using samples of primarily White children from middle-class homes. The present study includes a more diverse sample of children. Relatedly, the sample size employed in the present research was relatively larger than has often been used in investigations of the link between shyness and vocabulary (e.g., Coplan & Armer, 2005; Dixon & Smith, 2000), shyness and executive functioning (e.g., Lieberman, 2000; Ludwig & Lazarus, 1983), and executive functioning and vocabulary (e.g., Adams & Gathercole, 1995; Blair & Razza, 2007). An additional strength of the research was in its focus on processes by which shyness may come to be related to vocabulary. The results of this study extend previous work in two ways. First, the results provide evidence regarding the potential role of executive functioning in the relation between shyness and vocabulary acquisition, thereby adding

3. We thank an anonymous reviewer for this suggestion.

to our understanding of the role of temperamental characteristics in the development of cognitive abilities. Second, the results provide evidence that environmental stimulation moderates the mediation of executive functioning in the association between shyness and vocabulary. These results add to our knowledge of the ways in which temperamental characteristics, such as shyness, may influence vocabulary acquisition.

Future research is needed that not only examines different aspects of shyness and different types of vocabulary, as well as other aspects of knowledge, but also employs a longitudinal design to increase understanding of the nature of the relation between shyness and cognitive development, as well as the role that environmental stimulation might play in this relation. Results of such research would enhance our understanding of the contexts under which shyness may or may not interfere with cognitive and language development. Finally, whereas shyness in the United States has often been pathologized, there is evidence that shyness is not viewed as maladaptive in some non-Western cultures such as China (e.g., Chen, Rubin, & Sun, 1992). Therefore, it would be of interest to examine the extent to which results obtained in the present study would generalize to societies in which shyness is viewed as a valued characteristic of children.

The present study contributes to the extant literature by examining processes that may account for the link between shyness and vocabulary, which very few research studies have done, thereby adding to the theories on the relation between shyness and vocabulary. This research adds to the existing literature not only by examining the potential mediation of executive functioning in the relation between shyness and vocabulary but also by examining environmental stimulation as a moderator of this mediation. The results of this research provide an impetus for further research on the mechanisms by which shyness is related to vocabulary.

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